

## Response to “Impacts, mega-tsunami, and other extraordinary claims”

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Carl Sagan’s quote “*extraordinary claims require extraordinary evidence*”, used as a standard by Pinter and Ishman (2008) to refute our research, actually referred to alien abductions and the search for extraterrestrial intelligence. It was taken from Marcello Truzzi who referred to paranormal evidence. This quote is the Principal of Laplace “*The weight of evidence for an extraordinary claim must be proportioned to its strangeness.*” Impacts are not extraordinary claims and our data are extensive.

We limit our comments only to data and interpretations presented in our recent multi-authored, peer-reviewed PNAS paper (Firestone et al., 2007), which presents the Younger Dryas (YD) impact hypothesis and supersedes previous non-peer-reviewed publications. Pinter and Ishman incorrectly argue that evidence for the YD event is due to a “constant, noncatastrophic rain of sand-sized micrometeorites” and ignore the multi-proxy records upon which the YD hypothesis is based. In stratified sections at each of 10 sites investigated, from California to Belgium and Manitoba to Arizona, we found a <5-cm thick sediment layer dated to ~12.9 ka containing a majority of 14 markers, forming distinct stratigraphic peaks at above-background concentrations. The markers in this distinctive layer include magnetic microspherules (up to 2144/kg), magnetic grains (16g /kg) enriched in iridium (117 ppb, 6000× terrestrial values), vesicular carbon spherules (1458/kg), glass-like carbon (16 g/kg), nanodiamonds, fullerenes containing extraterrestrial concentrations of  $^3\text{He}$  (84×air), soot and charcoal (2 g/kg). Except for small quantities of magnetic grains and charcoal, these markers were undetectable at any site in the sediment either above or below the impact layer, representing stratigraphic sequences spanning >55 ka. These data are inconsistent with Pinter and Ishman’s assertion of a “constant” rain of meteoritic debris and demonstrate that a layer of concentrated ET markers was suddenly deposited ~12.9 ka ago.

We suggested that the Carolina Bays were formed by shockwaves from the YD impact event centered near the Laurentide Ice Sheet where the highest concentration of markers was found. At 15 Bays tested, the same impact markers are distributed throughout Bay sediments and rims, but not beneath them. The presence of the same assemblage of markers in the Bays suggests that they were in existence ~12.9 ka ago, although their age is currently unresolved. Pinter and Ishman fail to reference the long history of impact evidence summarized by Eyton and Parkhurst (1975) who suggested that the Bays are impact-related. We have found the first evidence of impact markers clearly associated with the Carolina Bays, which supports the hypothesis that they were formed during an extraterrestrial impact.

Pinter and Ishman criticize the lack of a known YD impact crater, and Luis Alvarez and colleagues faced similar criticisms about the KT impact until Chicxulub was discovered. They base that and other objections on the impact of a single ET object, though we made no such claim. Instead, we proposed that a heavily fragmented comet, composed of low-density components (Solem, 1994), exploded in multiple airbursts. The expanse of the YD impact layer is consistent with multiple airbursts causing continent-wide devastation and climate change as described by Toon et al. (1997).

Evidence now exists that many megafaunal taxa abruptly became extinct near the YD boundary. For example, Vance Haynes (2005) found that at more than 50 sites across North America, no megafaunal fossils or Clovis tools are found within or above the black mat, which overlies the layer containing impact markers. Haynes writes, “[T]he sudden extinction of the Pleistocene megafauna would be dramatically revealed by explaining that all were gone an instant before the black mat was deposited.” Regarding wildfires, we showed that at the onset of the enigmatic YD deglacial event the Greenland ice cores display one of the most extensive episodes of biomass burning in the past 100,000 years. We need only apply Occam’s razor to determine that the impact, extinctions, and onset of YD cooling are related.

Unfortunately, Pinter and Ishman misunderstood our results. Again quoting Carl Sagan, “*The truth may be puzzling. It may take some work to grapple with. It may be counterintuitive. It may*

*contradict deeply held prejudices. It may not be consonant with what we desperately want to be true. But our preferences do not determine what's true.... Cleverly designed experiments are the key”* (Sagan, 1995). We continue to test the Younger Dryas Impact hypothesis, but it is firmly based on empirical work and not conjecture.

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